NC Pesticide Illness and Injury Surveillance Program
Surveillance Findings 2012–2016

Summary

During 2012–2016, the North Carolina Division of Public Health (NC DPH) received an average of 1004 pesticide poisoning reports each year. Most pesticide poisonings occurred at home and during the summer months. People used pesticide products at home for a variety of reasons. Almost one out of four non-occupational cases involved children less than 18 years of age. Work-related exposures were less common, but those that occurred involved mostly younger workers and those who worked on a farm or were performing structural pest control or outdoor grounds-keeping tasks. Workers performing pesticide application and related activities were exposed to pesticides more frequently than those not involved in application activities. The majority of poisonings were of low severity and exposures involved insecticides, specifically pyrethroid products.

Where Can I Learn More?

For more information about the North Carolina Division of Public Health Pesticide Surveillance Program, visit http://epi.publichealth.nc.gov/oee/a_z/pesticides.html/.

Who Can I Contact if I Have Questions?

- If you have been exposed to a pesticide, contact Carolinas Poison Center at 1-800-222-1222.
- For questions about this report or pesticide exposure, please contact the Occupational and Environmental Epidemiology Branch at (919) 707-5900.

Background

The benefits of pesticides are well recognized and use is widespread. The majority of pesticides are used in agriculture (80%) and they are also commonly used in other settings such as schools, businesses and homes (1). The US Environmental Protection Agency regulates pesticides and tries to ensure that pesticides do not pose unreasonable risks to the public and the environment. However, over-exposures occur and can result in acute health effects ranging from mild symptoms such as headache, rash or flu-like symptoms to serious systemic effects, third-degree burns, and neurologic effects (2). Evidence is mounting that links pesticide exposure to chronic health effects such as neurological disorders, cancer, reproductive disorders, asthma, and skin disease (3). In 2007, North Carolina initiated a pesticide illness and injury surveillance program to track and respond to acute pesticide-related exposures at work and in the community. Findings are used to inform public health action to prevent pesticide exposure and associated injury and illness. This report summarizes surveillance findings during 2012–2016.

Methods

A case of pesticide illness is defined as an exposure to a pesticide product resulting in an acute adverse health outcome. Healthcare providers are required to report pesticide-related illness and injury cases to the NC Division of Public Health but for convenience, may report directly to the Carolinas Poison Center (CPC) (NC 10A NCAC 41F .0101 - .0103) since this group is commonly used for toxicology information and treatment advice by healthcare providers. To obtain circumstantial data, NC DPH investigates all occupational cases and select non-occupational cases that reach a certain severity level (death and hospitalization) which includes review of medical records and an interview.

Cases are classified as definite, probable, possible when available evidence supports a link between the pesticide exposure and the health outcome. Cases are classified as “definite” when objective evidence is available to confirm exposure and health effects; as “probable” on the basis of a mix of objective and self-reported information; and, “possible” when exposure and health effects data are self-reported. Cases are classified as “suspicious” when there may be either objective or self-reported exposure and health effects information but a clear link between the pesticide exposure and the health effects is hard to determine because there is limited toxicological data available about the pesticide product. Cases are classified as unlikely, insufficient information, asymptomatic or unrelated when evidence indicates there is no relationship between the pesticide exposure and health outcome.

A severity score of death, high, moderate or low is applied to each definite, probable, possible or suspicious case, and are defined based on the following criteria.

- High: severe symptoms, causing the person to seek treatment and usually experience restricted activities.
- Moderate: symptoms that are serious but less severe, causing the person to seek treatment and possibly experience restricted activities.

- Low: mild symptoms, that do not cause the person to seek treatment and does not result in restricted activities.

This case definition, classification scheme, and severity index was developed by the National Institute of Occupational Safety and Health (NIOSH), Sentinel Event Notification System for Occupational Risk (SENSOR) Pesticides Program, Center for Disease Control and Prevention (2). For this report only cases classified as definite, probable, possible, or suspicious (DPPS) during years 2012 – 2016 are included.

Findings

During 2012 to 2016, North Carolina received a total of 5,019 reports of acute pesticide illness or injury, an average of 1004 reports per year. A total of 2,142 (43%) reported cases were coded as DPPS of which 228 (11%) were occupationally related and 1,914 were non-occupational (89%) (Table 1). Only these cases are presented in the analysis. The number of occupational and non-occupational cases varied by year (Figure1) and a seasonal trend for exposures was observed (Figure 2). The primary source of all reports was the Carolinas Poison Center (97%) (data not shown).

Table 1. Distribution of All Pesticide Illness and Injury Reports to the Pesticide Illness and Injury Surveillance Program, North Carolina, 2012 - 2016.

Case Status	Occupational	Non-Occupational	Total
Definite Case	59	178	237
Probable Case	34	242	276
Possible Case	134	1493	1627
Suspicious Case	1	1	2
Subtotal	*228 (11%)*	*1914 (89%)*	*2142*
Unlikely Case	42	260	302
Insufficient Information	89	2448	2537
Exposed/Asymptomatic	3	13	16
Unrelated	13	9	22
Subtotal	*147*	*2730*	*2877*
	375	**4644**	**5019**

Figure 1. Number of Occupational and Non-Occupational Pesticide Illness and Injury Cases Reported by Year in North Carolina, 2012 to 2016.

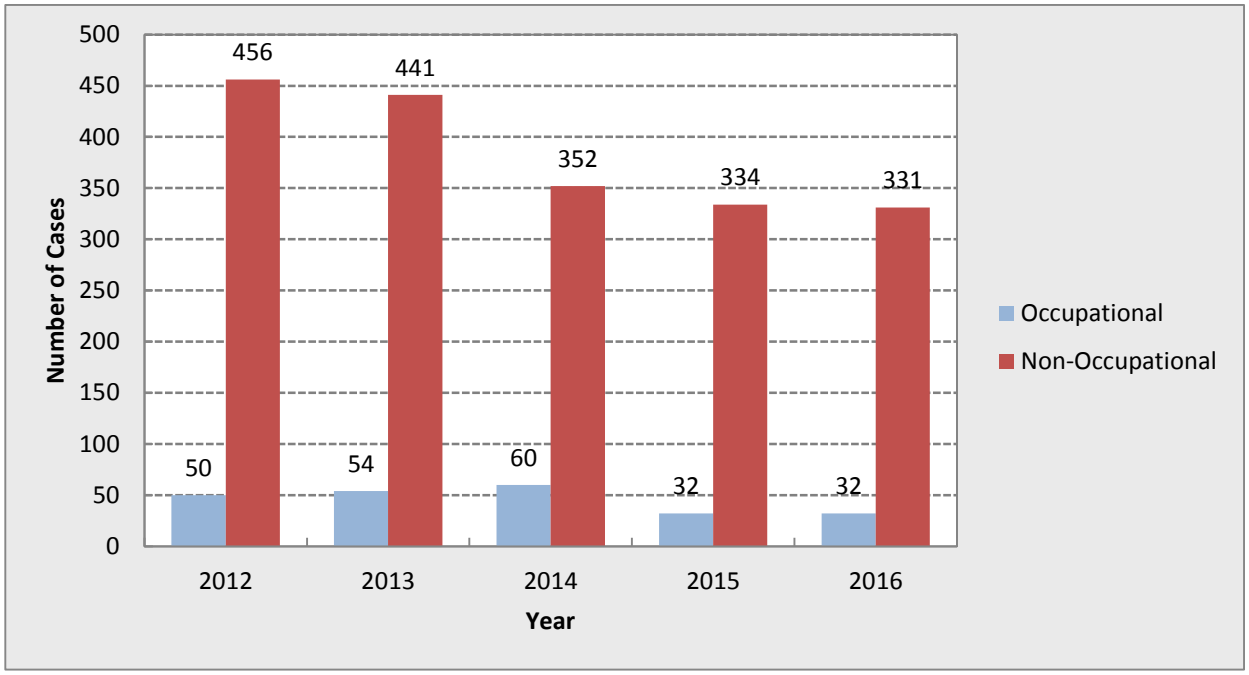
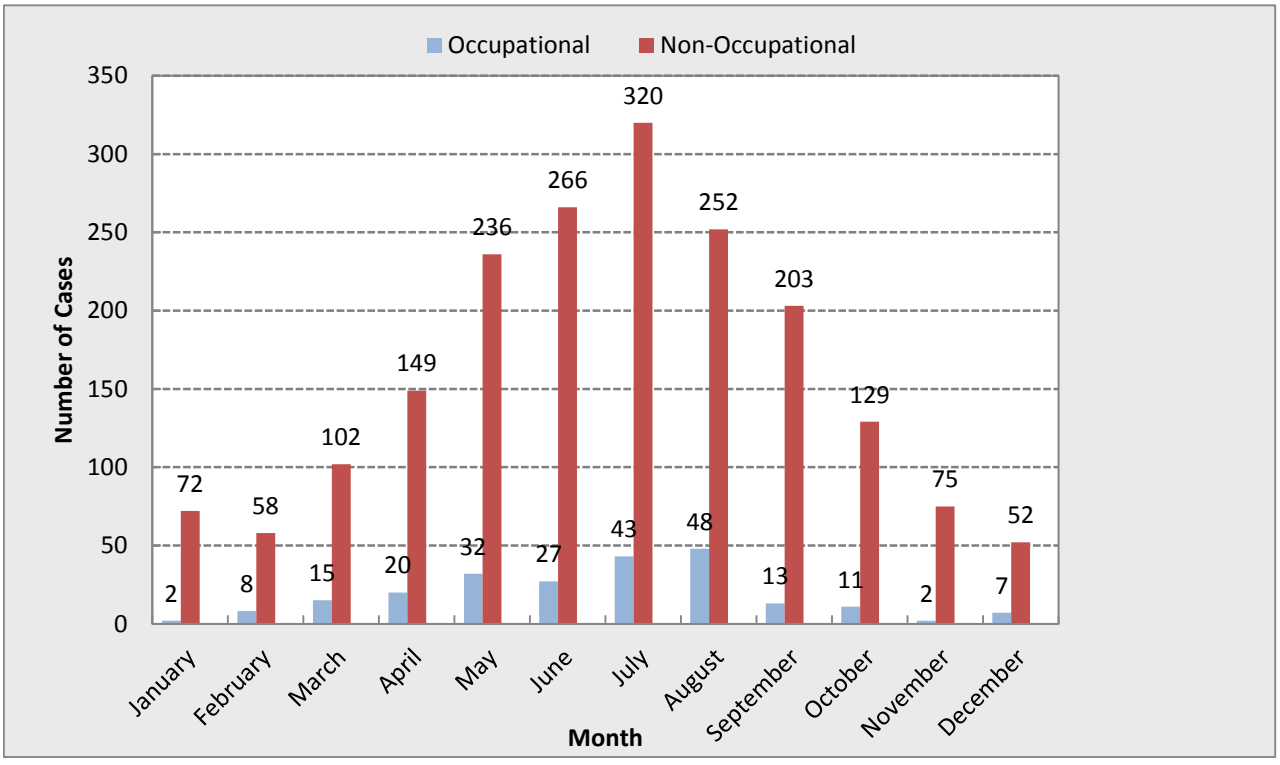


Figure 2. Number of Occupational and Non-Occupational Pesticide Illness and Injury Cases Reported By Month in North Carolina, 2012 - 2016.



Demographics

Most occupational cases were male (74%) and the largest proportion (26%) were aged 20–29 years old (Table 2). The most common occupation among poisoned workers was building, grounds-keeping and maintenance work (23%) comprised largely of pest control operators and landscaping workers, followed by farming, fishing and forestry work (21%) comprised largely of farm laborers (Table 3).

Table 2. Distribution of Occupational Pesticide Illness and Injury Cases by Age and Gender in North Carolina, 2012–2016.

Age Groups (years)	Female	Male	Total	Percent
<9	0	0	0	0.0%
10–19	6	8	14	6.0%
20–29	15	45	60	26.0%
30–39	16	38	54	24.0%
40–49	14	27	41	18.0%
50–59	10	24	34	15.0%
60–69	3	7	10	4.0%
70–79	1	2	3	1.0%
80+	0	0	0	0.0%
Unknown	0	12	12	0.0%
Total	**65**	**163**	**228**	**100%**

Table 3. Job Classes of Occupational Pesticide Illness and Injury Cases in North Carolina, 2012–2016.

Occupation *	Total	Percent
Building and Grounds Cleaning and Maintenance	52	22.8%
Farming, Fishing and Forestry	47	20.6%
Transportation and Material Moving	14	6.1%
Office and Administrative Support	13	5.7%
Protective Services	12	5.3%
Production	10	4.4%
Management	9	4.0%
Sales and Related	8	3.5%
Personal Care and Service	5	2.2%
Other	21	9.2%
Unknown	37	16.2%
Total	228	100.0%

* Categories based on 2002 Census of Occupation Codes.

Most non-occupational cases were adults aged 18 years and above (74%) (Table 4). Twenty four percent of non-occupational cases were children under 18 years, and most poisonings in this age group occurred in small children, five years old and younger (62%). Most non-occupational poisonings were female (54%).

Case Description
A farmer was filling a tank with Gramoxone SL 2.0 (paraquat herbicide) when the hose detached and sprayed him in the face. The farmer immediately rinsed his face with water and went home to shower. Presented to local emergency department with blistering to both cheeks, bridge of nose, and chin. Farmer transferred and admitted to a burn center. Diagnosed with second degree burns to face. PPE use unknown.

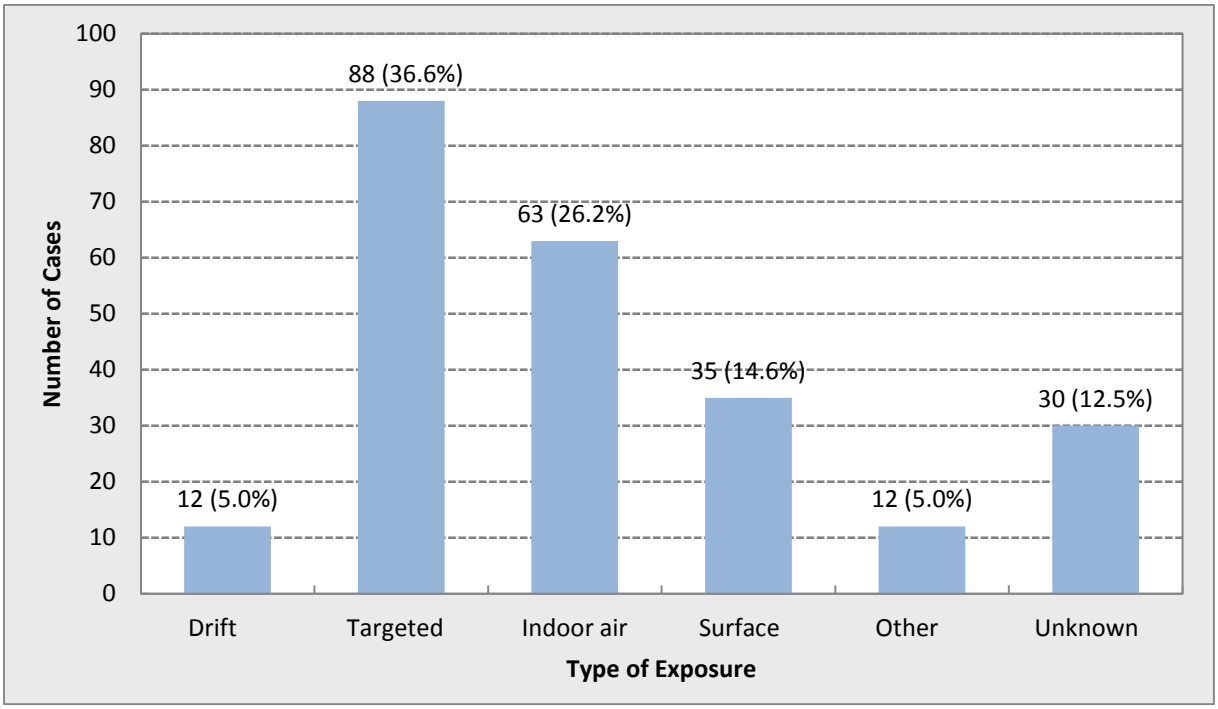
Table 4. Distribution of Non-Occupational Pesticide Illness and Injury Cases by Age and Gender in North Carolina, 2012 – 2016.

Age Groups	Female	Male	Number	Percent
<1: Infants	5	8	13	1.0%
01-02: Toddlers	60	87	147	8.0%
03-05: Preschool	54	56	110	6.0%
06-11: Child	38	53	91	5.0%
12-17: Youth	33	44	77	4.0%
18-64: Adult	685	531	1216	63.0%
65+ Senior	127	85	212	11.0%
Unknown	25	23	48	2.0%
Total	**1027**	**887**	**1914**	**100%**

Exposures

Occupational cases
Most workers had contact with pesticides through targeted exposure (37%) (Figure 3), which occurs when the pesticide is released at the target site and exposes the applicator through direct projection, ricochet, blow back by wind, or airborne exposure by moving through an area actively being treated. Half of the occupational cases involved Insecticides (Table 5); pyrethroids were the most common type of insecticide reported (55%) (data not shown).

Figure 3. Type of Pesticide Exposure for Occupational Pesticide Illness and Injury Cases in North Carolina, 2012–2016. *



* Total exceeds total number of occupational cases because some individuals had more than one type of exposure.

Table 5. Type of Pesticide Associated with Occupational Pesticide Illness and Injury Cases in NC, 2012 - 2016.

Pesticide Type	Cumulative	Percent
Insecticide	130	49.6%
Herbicide	49	18.7%
Fumigant	30	11.5%
Fungicide	10	3.8%
Insecticide & Other	9	3.4%
Insect Growth Regulator	5	1.9%
Insect Repellent	5	1.9%
Disinfectant *	3	1.1%
Herbicide & Other	3	1.1%
Other	11	4.2%
Multiple	1	0.4%
Unknown	6	2.3%
Total **	**262**	**100.0%**

* Data collection for disinfectants ceased May 2007 except for disinfectants containing algaecides.

** Total exceeds total number of occupational cases because some individuals were exposed to more than one type of pesticide.

Workers involved in application or related activities accounted for over half of occupational exposure cases (40% and 11% respectively). Related activities included mixing and loading; transport or disposal; repair or maintenance of the application equipment; or a combination of more than one of these activities (data not shown). Forty percent of occupational cases occurred during routine work activities not involving pesticide application. Examples of these include:

- Farmer cleaning out corn bin that once contained pesticide-treated corn
- Fire marshal entered dorm room just after fogger treatment
- Cashier scanning container of Sevin dust and it broke open
- Farmworkers on lunch break and felt drift from adjacent field

Multiple factors contributing to exposure among occupational cases were reported (Table 6). Lack of or inadequate, personal protective equipment (gloves, eye protection, respirator respectively) was the factor that contributed most often to occupational pesticide exposure (17%) followed by label violation not otherwise specified (NOS) (15%). Examples of NOS cases include:

- Pest control operator rubbed face during application
- Wind blew pesticide into worker's face
- Equipment operator drank from water cooler that had been used to mix pesticide

Table 6. Factors contributing to Exposure for Occupational Pesticide Illness and Injury Cases in North Carolina, 2012–2016.*

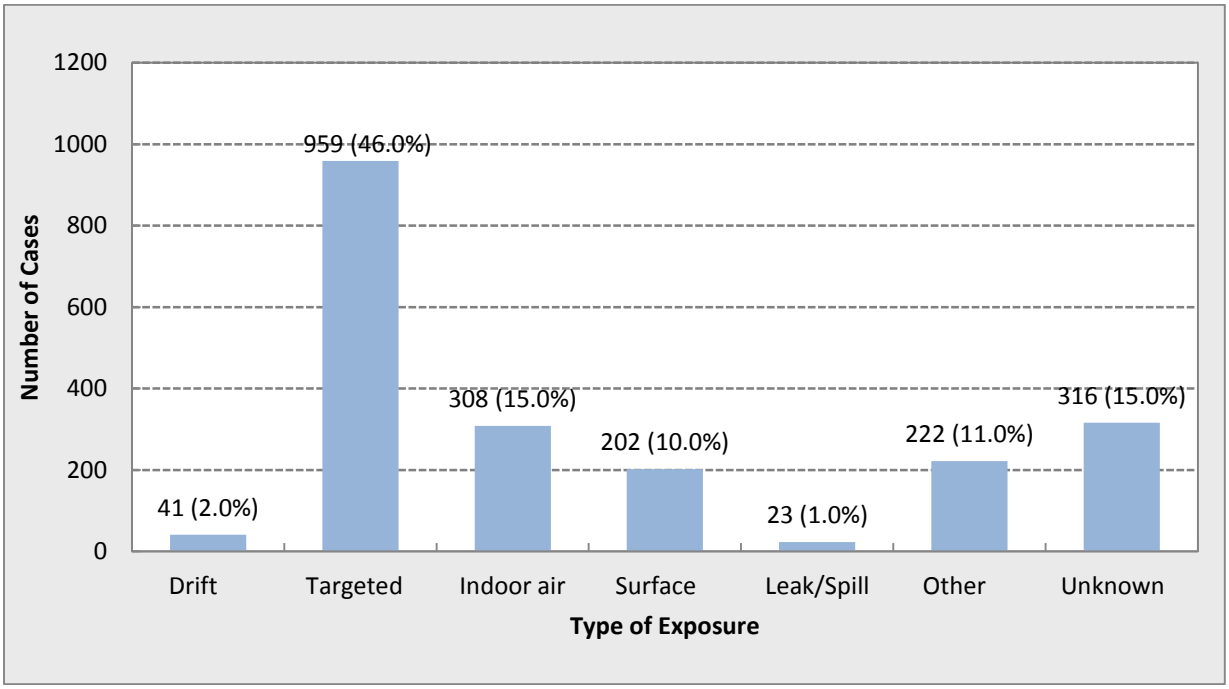
Contributing Factor	Total	Percent
Lack of required personal protective equipment	67	17.3%
Label violations NOS	57	14.7%
Applicator not properly trained or supervised	28	7.2%
Structure inadequately ventilated before re-entry	27	7.0%
Illegal pesticide used / Illegal dumping	26	6.7%
Spill/Splash of liquid or dust (not equipment failure)	23	5.9%
Application equipment failure	23	5.9%
Decontamination not adequate or timely	19	4.9%
Notification/posting lacking or ineffective	14	3.6%
People were in the treated area during application	13	3.4%
Excessive application	10	2.6%
Early re-entry	9	2.3%
Drift contributory factors	9	2.3%
No label violation identified but person still exposed / ill	5	1.3%
Intentional harm	3	0.8%
Mixing incompatible products	2	0.5%
Within reach of child or other improper storage	1	0.3%
Unknown	51	13.2%
Total	**387**	**100.0%**

* Total exceeds total number of occupational cases because some individuals had more than one contributing factor.

Non-Occupational Cases

Similar to occupational cases, non-occupational cases had contact with pesticides mostly through targeted exposure (46%) (Figure 4) and insecticides accounted for a significant proportion of the exposures (59%) (Table 7). The type of insecticide most commonly involved was pyrethroids (37%) (data not shown).

Figure 4. Type of Exposure Associated with Non-Occupational Pesticide Illness and Injury Cases in North Carolina, 2012 - 2016.*



* Total exceeds total number of non-occupational cases because some individuals had more than one type of exposure.

Table 7. Type of Pesticide Associated with Non-Occupational Pesticide Illness and Injury Cases in NC, 2012 - 2016.

Pesticide Type	Cumulative	Percent
Insecticide	1158	58.6%
Herbicide	190	9.6%
Insect Repellent	163	8.2%
Disinfectant*	133	6.7%
Insecticide and Other	126	6.4%
Insect Growth Regulator	29	1.5%
Fungicide	22	1.1%
Fumigant	12	0.6%
Rodenticide	41	2.1%
Herbicide & Other	4	0.2%
Other	35	1.8%
Multiple	2	0.1%
Unknown	61	3.1%
Total **	**1976**	**100.0%**

* Data collection for disinfectants ceased May 2007 except for disinfectants containing algaecides.

** Total exceeds total number of non-occupational cases because some individuals were exposed to more than one type of pesticide.

Non-occupational poisonings occurred primarily at home (96%) (data not shown) and the most common types of equipment used to apply pesticides were spray cans (19%) followed by manual application (17%) (Table 8). Examples of products manually applied include: mothballs, pet products, lice shampoo, pool tabs, snake repellants and spreadable dust for garden insects. Cases involving crop spraying equipment (e.g., ground sprayer, aerial application, soil injector etc.) were associated with drift from an airplane or ground application nearby. Application targets for non-occupational pesticide use varied (Table 9) and most affected individuals were applying when exposed (44%) (data not shown).

Case Description

A four year old child drank Lorsban (organophosphate insecticide) that was in a Sun Drop bottle in great uncle's garage. The uncle was fishing and hitting golf balls with child's dad when child went into garage. Dad found son with spilled, 8 oz Sun drop bottle and emesis with strong pesticide odor. Child admitted to hospital intensive care unit agitated, with rapid heart rate, copious lung secretions, blood count and kidney function changes, and chest x-ray changes. Great Uncle did not remember where he got the pesticide from.

Table 8. Type of Equipment Associated with Non-Occupational Pesticide Illness and Injury Cases in North Carolina, 2012 - 2016.

Application Equipment	Total	Percent
Pressurized can	363	19.0%
Manual Placement	316	16.5%
Total Release Foggers	209	10.9%
Trigger pump/compressed air	199	10.4%
More than one type of equip.	14	0.7%
Ground sprayer	11	0.6%
Aerial application equipment	11	0.6%
Soil injector	10	0.5%
Spray line, hand held	9	0.5%
Sprayer, backpack	7	0.4%
Handheld granular/dust application	3	0.2%
High pressure fumigator	2	0.1%
Air Blast Sprayers	2	0.1%
Aerosol generator/fogger	1	0.1%
Other	5	0.3%
Not applicable	195	10.2%
Unknown	557	29.1%
Total	**1914**	**100.0%**

Table 9. Application Targets Associated with Non-Occupational Pesticide Illness and Injury Cases in North Carolina, 2012 – 2016.

Application Target	Total	Percent
Building surface	265	*13.8%*
Human	144	*7.5%*
Landscape/ornamentals	57	*3.0%*
Veterinary - domestic animals	53	*2.8%*
Pool, Spa, Hot Tub, Jacuzzi	44	*2.3%*
Undesired plant	33	*1.7%*
Bait for rodent, bird, predator	29	*1.5%*
Building structure	18	*0.9%*
Crops	29	*1.5%*
Soil	6	*0.3%*
Building space treatment	3	*0.2%*
Aquatic-pond, stream, lake, canal	2	*0.1%*
Forest trees/land	2	*0.1%*
Veterinary - livestock	2	*0.1%*
Wood product	2	*0.1%*
Community-wide application	1	*0.1%*
Other	60	*3.1%*
Not applicable	338	*17.7%*
Unknown	826	*43.2%*
Total	**1914**	**100.0%**

Health Outcomes

Occupational Cases

Most occupational cases were of low severity (81%) (Table 10). The most common route of exposure was inhalation (40%) followed closely by dermal exposure (35%) (Table 11). Those affected experienced a variety of symptoms (Table 12). Most cases only sought treatment from the Carolinas Poison Center (59%). 39% of occupational cases called poison control then sought higher levels of treatment (doctor's office, emergency medical services, emergency department, hospital) (data not shown).

Case Description

A man states bad bed bug problem in his 29 foot RV. He sprayed, stayed in the vehicle, and never ventilated it. He sprayed an unknown, exterminator product containing lambda cyhalothrin (pyrethroid insecticide) every two weeks for a total of eight times, spraying a gallon every time he used it. When that ran out, he switched to Hot Shot Bedbug & Flea Home Insect Killer (pyrethroid insecticide). He lost count of how many times he sprayed. He just knows he used the products every 14-20 days for months. He would wear a mask with filters on each side. He became very sick and was admitted to the hospital with difficulty breathing, altered mental status, nasal drainage, productive cough, tremors, abnormal chest x-ray, liver changes and electrolyte imbalance. He said he read the label but did not pay much attention to it except for the how often you could spray.

Non-Occupational Cases

Most non-Occupational cases were of low severity (83%) (Table 10). The four fatalities that occurred were suicides. The most common route of exposure was inhalation (37%) (Table 11). Patients experienced a variety of symptoms (Table 12). Most cases only sought treatment from the Carolinas Poison Center only (69%). 29% of non-occupational cases called poison control then sought higher levels of treatment (doctor's office, emergency medical services, emergency department, hospital) (data not shown).

Table 10. Severity of Occupational Cases and Non-Occupational Pesticide Illness Cases in NC, 2012 – 2016.

	Occupational		Non-Occupational	
Severity	**Number**	**Percent**	**Number**	**Percent**
Fatal	0	0.0%	4	0.2%
High	2	0.9%	15	0.9%
Moderate	42	18.4%	213	15.7%
Low	184	80.7%	1682	83.4%
Total	**228**	**100.0%**	**1914**	**100.0%**

Table 11. Route of Exposure for Occupational Cases and Non-Occupational Pesticide Illness and Injury Cases in North Carolina, 2012 – 2016.

	Occupational		Non-Occupational	
Route of Exposure	**Total**	**Percent**	**Total**	**Percent**
Inhalation	117	40.3%	759	40.0%
Dermal	100	34.5%	529	35.0%
Ocular	50	17.2%	528	17.5%
Ingestion	13	4.5%	268	2.5%
Injection	0	0.0%	6	0.0%
Unknown	10	3.5%	137	5.0%
Total*	290	**100.0%**	2227	**100%**

*Totals exceed total number of occupational and non-occupational cases because some individuals had more than one route of exposure

Table 12. Reported signs and Symptoms Associated with Occupational and Non-Occupational Pesticide Illness and Injury Cases in North Carolina, 2012 – 2016.

	Occupational		Non-Occupational	
Sign and Symptom Category	**Number**	**Percent**	**Number**	**Percent**
Neurological	115	18.9%	520	14.5%
Gastrointestinal	96	15.7%	488	13.6%
Respiratory	95	15.6%	784	21.9%
Dermal	88	14.4%	517	14.5%
Ocular	78	12.8%	634	17.7%
General	77	12.6%	333	9.3%
Cardiac	60	9.8%	284	7.9%
Renal	1	0.2%	18	0.5%
Total*	610	100.0%	3578	100.0%

*Totals exceed total number of occupational and non-occupational cases because some individuals had more than one type of symptom

Limitations

Counts in this report are likely underestimates. Not all people who become ill from pesticides recognize the source of their illness or report their exposure to a clinician. There is likely recall bias and possible reluctance to disclose all information for interviewees. Additionally, clinician reporting may not be consistent.

Investigations are attempted for all work-related cases. Approximately half of these cases are lost to follow-up (no call backs or refusals), which leads to insufficient information about the events surrounding the pesticide exposure. Only serious non-occupational cases are investigated (e.g. deaths and hospitalizations) which limits what we know about these cases.

Public Health Significance

- Clinicians should consider acute pesticide poisoning when patients present for care during summer and early fall.
- In North Carolina, domestic exposures to pesticides are common and almost one of every four persons exposed at home is a child under 18 years of age.
- The predominance of domestic exposures in North Carolina is consistent with national poison control data and other state pesticide surveillance programs (4, 5) and reaffirm the importance of tracking these events and educating the general public on the safe use and storage of pesticide products.
- Pesticide products are used for a variety of reasons at home thereby increasing the risk of exposure. Pesticides are used to treat the interior surfaces of homes (e.g. carpets and other surfaces in living/working areas), and to treat lawns, gardens, pets, pools, and backyard mosquitos. Home owners should always read the product label to prevent accidents. Additionally, to reduce risk of exposure at home the US Environmental Protection Agency recommends that these alternatives be considered first: pest prevention measures and non-chemical pest control or Integrated Pest Management (6).
- Home owners continue to experience accidents when using foggers for pest control. National data indicate exposures occurred when users fail to vacate during application, re-enter too early, use too many foggers for the treated space, or the user failed to notify others (7). Time should be taken before the application to read the label for proper use.
- Occupational exposures tend to affect younger workers and those in certain industries such as services and agriculture and occupations such as pest control, grounds-keeping and farm work. Workers were exposed most often during application and related activities such as mixing, loading, transport or maintenance/repair of pesticide application equipment. Safety precautions need to be taken, during all phases of the pesticide handling process (8). The pesticide label provides detailed information on specific personal protective equipment and handling.
- Insecticides, particularly pyrethroid pesticides, account for most of the pesticide exposures at home and at work, similiar to national findings (9, 10). At home, these pesticides are contained in household sprays, aerosol bombs, insect repellents, pet shampoos, and lice treatments. At work, they are used in agriculture and structural pest control. While this class of insecticides is less acutely toxic than most other insecticides, they are not risk free, and following label instructions is still important.
- Most exposures result in low severity outcomes. Nonetheless, pesticides have the potential to cause serious acute illness, and chronic health effects may be associated with chronic, low-level or sub-acute pesticide exposure over time (3).
- Data suggest a possible decreasing trend in acute pesticide illness and injury events during 2012 – 2016.

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May, 2018.

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